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ABSTRACT

The effects of the Attention Directing Strategy and Imagery Cue Strategy as program embedded learning strategies for microcomputer-based instruction (MCBI) were examined in this study. Eight learning conditions with identical instructional content on the parts and operation of the human heart were designed: either self-paced or externally-paced, and including one, both, or neither of the above strategies. A control group received no instruction. Other variables included difficulty of learning tasks, ranging from a simple memory task to a more difficult problem-solving task, and the cognitive style aspects of reflectivity and impulsivity as measured by the Barratts test. Subjects were 180 freshman psychology students at Ohio State University. Results supported the following hypotheses: (1) the externally-paced MCBI design is generally more effective than the self-paced design; (2) the Imagery Cue Strategy improves learning of spatial information for performance on spatial tasks; (3) the Attention Directing Strategy improves learning of spatial information for performance on spatial tasks; (4) the combination of Imagery Cue and Attention Directing Strategies improves learning of spatial information over either strategy alone; and (5) program embedded learning strategies have different effects on learning depending on whether the basic design is self- or externally-paced. Statistical analyses, a sample instructional display, and a list of 17 references are appended. (MES)

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The Effects of Program Embedded Learning
Strategies, Using an Imagery Cue Strategy
and an Attention Directing Strategy, To
Improve Learning from Micro Computer
Based Instruction (MCBI)

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Rationale

This study represents the third in a series of studies dealing with micro-computer based instruction (MCBI) done by the author's Ohio State-Penn State Research Group on Instructional Design and Technology. This research group was started by Canelos and Taylor, with a first study in 1979 (1980a, 1980b), and has generated a series of published research studies since that time.

The initial study dealing with MCBI examined the relative effectiveness of a basic Self-Paced MCBI method and an External-Paced method, (1985a, 1985b). While Self-Paced methods are recommended for many learning situations involving MCBI, this first study found that an External-Paced instructional method improved learning by increasing attention and motivation. This effect held constant, favoring External-Paced over Self-Paced, even for the more difficult learning tasks evaluated, specifically complex concept learning and solving a spatial problem.

The External-Paced method, as a basic method, or strategy, for designing MCBI, was recommended from the results of our initial study because of these increased levels of learning caused by increased attention and motivation. However, it should be noted that a more aggressive External-Paced strategy was tried in this study, and was ineffective. External pacing of MCBI can be effective, but such external pacing must allow enough time for reading, and the cognitive processing of new information, (called cognitive processing time in the initial MCBI Study).

The second study on MCBI, further examined the relative effects of Self Paced and External Paced instructional strategies, (1986; 1987), but added additional learning strategies. Our earlier work on imagery learning, strategies, imagery memory, and encoding specificity, (1981, 1982, 1983, 1984) and cognitive psychology (1982), indicated that imagery memory factors can have a significant impact on the overall acquisition, and recall of information. This impact is particularly true for spatial learning tasks. Other researchers have indicated similar results regarding the effects of imagery on memory and recall, for example Paivio (1970) has done extensive work on imagery, and the work by Kosslyn (1975) is quite interesting regarding the reconstruction of visual memory elements. Therefore, we decided to incorporate imagery strategy effects into our basic MCBI Self-Paced and Externally-Paced instructional conditions. A further consideration was the use of an attention directing strategy, having effects similar to an advance organizer. Recall that early work by Ausubel (1968) and Rothkopf (1967) found positive learning effects using

strategies that directed the learners attention towards relevant to-be-learned information, either instructional questions, performance objectives, or post-questions. Since MCBI is basically an individual or independent type of learning experience, such attention directing learning strategies should help the learner identify relevant information that should be learned. Some researchers have already indicated that learners may be very poor judges of what should be learned, and in what order, or how to learn information from MCBI instruction, (Carrier, 1984; Reiser, 1984).

The Attention Directing Strategy was designed to direct the learners attention to spatial information that had to be acquired to be able to solve the spatial learning problem. In our first MCBI study, we found that learners were acquiring verbal information, for use on the concept tasks, but missing a significant amount of spatial information. The MCBI program instructed the learner on the names of the parts of the human heart, and the operation of the heart, thru a series of 57 instructional frames, or computer displays, and instructional questions, and optional feedback loops. Since the information to-be-learned was both verbal and visual, both types of information had to be acquired to complete the five post tests. However, in the first study it was apparent that subjects were not acquiring as much visual information as they should when compared to verbal information acquisition. It was hypothesized that subjects concentrated on verbal information, because the MCBI program instructional questions required a verbal response, thus cueing subjects that verbal information was critical. Similarly, in the classroom situation learners acquire information verbally but may ignore visual information, if it is not emphasized and a significant aspect of testing. The Attention Directing Strategy tended to adjust for this effect by forcing attention to visual information. This strategy was program embedded, in the sense that it was built into the MCBI program, not learned by subjects prior to starting the MCBI program. The Attention Directing Strategy consisted of a 5-second time delay after the visual information in the instructional display was generated, but prior to any verbal explanation. So the learner would see, for example the visual of the heart with the chambers labeled, then 5-seconds pass, prior to any additional verbal description. It should be noted here that a typical instructional display in the MCBI program consisted of a visual of the heart and parts, with labels and arrows, followed by verbal descriptive information, then an instructional question, feedback and an option for a feedback loop, (see figure 3). The 5-second delay caused the learner to concentrate on the visual portion of the instructional display prior to receiving any competing verbal information. The second strategy was an Imagery Cue Strategy. It was hypothesized that this would further

enhance visual learning by causing the learner to form mental images of information acquired, by reconstructing the heart and heart parts from memory into imagery form. The Imagery Cue Strategy was a program embedded strategy, and operated in the following way. After every 5 to 7 completed instructional displays the learner was given a display with an outline drawing of the heart, and asked to fill in the heart parts learned so far by forming an image in his mind. The subject was given 15 seconds to form and manipulate this memory image. While this second study was quite complex, involving an additional trained imagery strategy, and the cognitive style of reflectivity-impulsivity in an 80 cell experimental design, the Attention Directing Strategy and Imagery Cue Strategy resulted in significant effects. The Attention Directing Strategy and Imagery Cue Strategy improved learning on both spatial learning tasks; the Spatial Cued Recall Task, and Spatial Problem Task. The Spatial Problem Task score went from (6.55) overall in the first study, to (9.71) in the second, and the Image Cue Strategy combined with the Attention Directing Strategy had a Spatial Problem Task score of (10.24) for External Paced, and (10.41) for Self Paced. However, due to the complexity of the 80 cell experimental design, there were confounding effects so it was difficult to determine the exact effect of these two strategies when learning from MCBI.

The present study was designed to further examine the effects of the Attention Directing Strategy and Imagery Cue Strategy, as program embedded learning strategies. However, the third studies design was developed to eliminate any confounding effects between instructional variables (see figure 2). Additionally, it was hypothesized that that program embedded learning strategies may operate differently contingent upon the basic MCBI program design of Self-Paced versus Externally-Paced. The research hypothesis for the present study are:

- 1) The Externally-Paced MCBI basic Program design will be generally more effective than the Self-Paced MCBI design.
- 2) The Imagery Cue Strategy will improve the learning of Spatial information for performance on Spatial Tasks.
- 3) The Attention Directing Strategy will improve the learning of Spatial information for performance on Spatial Tasks.
- 4) The combination of an Imagery Cue Strategy and an Attention Directing Strategy will improve the learning

of Spatial information over either Strategy alone.

- 5) Program Embedded learning Strategies will have different effects upon learning, contingent upon the basic design of the MCBI program of Self-Paced or Externally-Paced.

Experimental Design and Procedures

The experimental design of the present study is a 9 x 5 x 2 repeated measures design. As can be seen in the block design in figure 1, there are 8 MCBI instructional conditions with, 1 control group, making up the between groups variable. There are 5 levels of the within groups variable that constitute a series of increasingly difficult learning tasks. A second between groups variable is the cognitive style variable of Reflectivity and Impulsivity. The cognitive style data was collected using the three parts of the Barratts test (Barratt and Patton, 1983). These three tests from the Barratt will be analyzed separately and presented in another research paper.

MCBI Experimental Condition

Each of the 8 MCBI conditions were designed to teach subjects about the parts and operation of the human heart during systolic and diastolic functioning. The instructional content was an adaption of the original Dwyer stimulus materials, (heart materials). The instructional content in each of the MCBI programs and sequence of content was identical. Each instructional program contained 57 instructional displays which consisted of visual and verbal instruction describing the heart parts and heart functions. Each display of instruction consisted of a visual with a verbal description and arrow, or arrows, pointing out the important information in that display. There were three types of visuals used in the instructional programs (figure 3). Each instructional display consisted of some combination of one of the visuals and a verbal explanation. Each of the micro-computer instructional programs will be described in detail. The graphics and text were authored using Apple Super PILOT. Verbal instruction was presented in each program, at a normal reading speed, (300 words/min.) although 4 programs are externally paced at the point of instruction and elaborate feedback.

1) Self Paced Instructional Program

The SP instructional program is self-paced at the point of instruction and feedback. Each of the 57 instructional displays start with the heart drawing, then part or phase names appear, then an arrow, or arrows, followed by the instructional text. After each completed instructional display is generated, the learner has as much time as desired to study the instructional display. To move on, the learner presses the return key to receive an instructional question. The instructional display is removed prior to the presentation of each of the 57 questions. The learner responds to the instructional questions by typing in the correct response. The program accepts not only the standard spelling for correct answers but plausible misspellings as well. If the correct response is entered, correct feedback is given in the form of simple feedback (i.e., right, correct). If an incorrect answer is typed in, simple feedback is given that the response is incorrect. The student is then given the option of receiving elaborate feedback, which is the repeat of the instructional display. However, this feedback is completely optional; he or she can move to the next instructional display without feedback. Both the instructional display and the elaborate feedback aspect of the instructional program were completely self-paced.

2) Self-Paced; Imagery Cue Strategy plus Attention Directing Strategy

Instructional condition 2 was identical to condition 1, but with the addition of 2 program embedded strategies. Condition 2 had a Self-Paced MCBT program as the basic instructional design, combined with the program embedded Imagery Cue Strategy and Attention Directing Strategy. The Imagery Cue Strategy was a special screen display designed to promote the formation of mental imagery of parts of the heart. After every 5 to 7 instructional displays, in the series of 57 instructional displays, an Imagery Cue display was given. This screen display was an outline of the heart, without parts or labels, and a verbal direction to form a mental image of the parts of the heart seen so far and their location and labels. This screen display stayed up for 15 seconds, then the instructional program continued. The Attention Directing Strategy was designed to help the learner attend to the visual information in each instructional display, prior to studying verbal descriptions presented. To accomplish this the Attention Directing Strategy, was a 5 second time delay between the presentation of the heart visual and labels, and the verbal descriptive information. During this 5 second delay, the learner could not move ahead, or get additional information. Each of the 57 instructional displays had this 5 second delay between

the visual and verbal descriptive information with the Attention Directing Strategy.

3) Self-Paced; Imagery Cue Strategy

Instructional condition 3, was identical to condition 1, but included the Imagery Cue Strategy. Of course, this was identical to the Imagery Cue Strategy from condition 2. As with condition 2, the imagery Cue Strategy was given every 5 to 7 instructional displays, in a special screen display, that lasted for 15 seconds.

4) Self-Paced; Attention Directing Strategy

Instructional condition 4, was identical to condition 1, but included the Attention Directing Strategy. This was the same Attention Directing Strategy from condition 2. The Attention Directing Strategy was a 5 second delay between the generation on the display screen of heart visual information, and verbal descriptive information.

5) Externally-Paced Instructional Program

The EP Instructional Program is externally paced at the point of instruction and elaborate feedback. The 57 instructional displays are identical to the SP instructional condition; containing the same content, in the same order, with each display generated in the same way, and at the same rate. However, the external pacing begins after the instructional display is completed. After each instructional display is completed, the program times the student's interaction with the completed display at a pace of: (a) 1 second per each line of verbal instruction, plus 1 second; so for 5 lines, 6 seconds for reading are given; (b) 7 seconds for cognitive processing are then given, after 1 second per line, plus 1 second, time has elapsed; (c) after reading time and cognitive processing time has elapsed, the instructional display is removed from the terminal screen. To move ahead, the learner presses the return key to receive the instructional question. The learner has as much time as required to respond. If the correct answer is entered, simple feedback is given and the student moves to the next instructional display. If the incorrect answer is typed in, simple feedback is given that indicates an incorrect answer. As in the SP condition, the learner is given the option of receiving elaborate feedback, which is the repeat of the instructional display containing the required answer. The elaborate feedback is optional; the learner can move to the next instructional display or take feedback. Feedback is a repeat of the instructional display and is timed the same way, not allowing self-paced elaborate feedback. Therefore, in the EP instructional program, both instruction and elaborate feedback are externally paced.

6) Externally Paced; Imagery Cue Strategy plus Attention Directing Strategy

Instructional condition 6 was identical to instructional condition 5, but with the addition of the two program embedded strategies of an Imagery Cue Strategy, and an Attention Directing Strategy. The instructional content and content sequence were identical, and the external pace system was identical to condition 5. The combined Imagery Cue Strategy and Attention Directing Strategy were presented in a program embedded format, in the same way they were presented in condition 2. The Imagery Cue Strategy was a special screen display, every 5-7 instructional displays, prompting the learner to form a mental image of the heart parts learned. The Attention Directing Strategy was the 5 second delay, occurring in each instructional display, between the spatial information, and verbal descriptive information.

7) Externally Paced; Imagery Cue Strategy

Instructional condition 7 was identical to instructional condition 5, in terms of content and content sequence and EP instructional design, but with the addition of the Imagery Cue Strategy. The Imagery Cue Strategy was a program embedded strategy and was presented in the same way in condition 7 as the other applications of the Imagery Cue Strategy previously described.

8) Externally Paced; Attention Directing Strategy

Instructional condition 8 was identical to instructional condition 5, in terms of content and content sequence and EP design, but with the addition of the Attention Directing Strategy. The Attention Directing Strategy was a program embedded strategy and was presented in the same way in condition 8 as the other applications of the Attention Directing Strategy previously described.

9) Control

To determine the base rate of the subject's pre-instructional program knowledge of heart physiology, a control group was randomly formed from the pool of 180 subjects participating in the study. The control group took the five tests, but received no instruction. The control group method was used, as opposed to a pre-test for all subjects, because it was felt that a pretest would serve as an advance organizer, and therefore add an intervening variable to the study. This intervening effect was of a particular concern for this study since one of the program embedded strategies was an advance organizer condition.

Learning Task Conditions

The within groups factor represented the different levels of objectives, or learning tasks, and consisted of the five achievement tests to evaluate the amount of information acquired and competency level with learned information. To do this, the five tests ranged in difficulty from a simple memory task to a more difficult problem solving task. Each of the five tests contained a total of 20 possible points, and will be described according to level of intellectual difficulty, simple to difficult.

1) List Learnings Task

The list learning task is a simple memory task, requiring the learner to list the names of the parts of the heart.

2) Spatial Learning Task, Cued-Recall

The spatial learning task, cued-recall, consisted of 20 multiple choice items designed to test the spatial learning of heart part location. The test contained a line drawing of the heart with numbers and arrows indicating where each part was located. The 20 test items appeared under the numbered drawing and required the subject to identify specific parts and locations.

3) Simple Concept learning Task

The simple concept learning task contained 20 multiple choice items. Each item provided in the item stem a description of a critical attribute about a heart part or operation. The learner selected the heart part name or operation name from the available choices.

4) Complex Concept Learning Task

The complex concept learning task contained 20 multiple choice items. The items were complex in the sense that they involved "if-then" relationships of the parts of the heart during heart operation, or what could be defined as disjunctive concepts.

5) Spatial Learning Problem, Free-Recall

The spatial learning problem, free recall was considered the most difficult of the five tasks. The learner had to prepare from memory a line drawing of the heart, with the parts in the correct location and labeled. Then the learner had to indicate blood flow through the heart pump system, by drawing a series of dotted lines connecting how the parts interact during heart operation.

The tests were administered off-line, and in a sequence that eliminated cues for the free recall conditions; list learning and spatial learning problem.

Subjects participating in the study were first term freshmen enrolled in a beginning level General Psychology course at Ohio State University. Subjects received course credit for participation in the study, but had to complete all phases of the study to receive credit. There were 180 subjects participating in the study, all of these subjects were randomly distributed to the 8 instructional conditions and 1 control condition. Subjects were directed to arrive at the experiment's location on campus at a specific day and time over two consecutive days. Sixteen hours were blocked off over two days to complete the study. Two hours of time were provided for each instructional condition, cognitive tests, and post-tests.

There were 20 subjects in each instructional condition, and the control group. Subjects were assigned to work in the two computer rooms, each computer room had a proctor. All subjects started their instructional program at the same time and were required to work through the instructional program independently. Prior to beginning the program the Barratts was administered on-line. All three parts of the Barratts were given and data collected on each subject. The Barratts took 20-25 minutes to complete, the heart instructional programs took from 25-30 minutes to complete. After completing the MCBI work, subjects were directed to a testing room, and received the five post-tests. The tests were administered by one of the experimenters, and subjects were required to work independently on their test package. All 180 subjects arrived and completed the study. While this seems surprising, the credit received amounts to a significant project in their Psychology course.

Data Analysis and Summary

The analysis of variance results are presented in Table 1. The between subject variable of Instructional Condition resulted in a significant F-ratio, as did the within subjects variable Test Type. However, there was a significant interaction between Instructional Condition and Test Type, so the main effect mean scores will not be analyzed with a follow-up analysis method.

The overall table of mean scores are presented in Table 2. A descriptive analysis of Table 2 indicated that the Externally Paced (EP) conditions using the program embedded learning strategies tended to have better overall mean scores, when compared to the Self-Paced (SP) conditions using program embedded strategies. The EP plus Imagery Cue Strategy tended to have higher mean scores across learning tasks, and the EP plus Attention Directing Strategy was close to this performance level. The Imagery Cue Strategy and Attention Directing Strategy, used in conjunction with the EP MCBI design, tended to have superior overall test scores than did the SP MCBI conditions using the same program embedded strategy. The beneficial effect of the Imagery Cue Strategy, and Attention Directing Strategy with the EP design, was strongest for the spatial learning tasks of Spatial Learning Cued Recall, and Spatial Learning Problem. The EP plus program embedded learning strategies overall mean score on the Spatial Learning Cued Recall task was (13.17) compared to the SP score of (10.92) using program embedded strategies. On the Spatial Learning Problem the EP plus program embedded strategies score overall was (10.67), compared to the SP only, and SP plus program embedded strategies score overall of (7.94). The EP using both strategies, of Imagery Cue and Attention Directing, had the highest mean scores on the Spatial tasks; Spatial Learning Cued Recall (13.40), Spatial Learning Problem (12.10). Another interesting finding in Table 2, is the similarity between SP and EP performance when program embedded strategies are not used. Further, note that the Imagery Cue Strategy and Attention Directing Strategy seemed to have improved learning more effectively for the EP, MCBI design, and not for the SP, MCBI design. An additional interesting result, in this descriptive analysis of Table 2, is the high scores on the List Learning task for the EP, plus Imagery Cue and Attention Directing Strategies, and the EP plus Imagery Cue Strategy (13.55; 14.35). This seems to indicate that imagery may be beneficial to list learning of verbal information. Finally, the descriptive analysis of Table 2, indicates that the Control Group had little or no knowledge of heart physiology with an overall mean score of (4.79).

The follow-up analysis appears in Table 3, and figure 2 presents a graph of the interaction. A Tukey follow-up analysis was used with an Alpha set at (.01). Looking at Table 3, the reader will find a listing of all mean comparisons within each instructional condition. The 8 instructional conditions are represented, with 10 comparisons, representing each learning task score in each column. Significant mean differences are in parenthesis. Note that the mean scores have a letter subscript indicating which learning task they represent; (List = L, Spatial Cued = S, Simple Concept = SC, Complex Concept = CC, Spatial Problem = SP).

Looking at the pattern of means for the SP and EP instructional conditions finds a similar set of scores. The EP conditions using the program embedded strategies of an Imagery Cue Strategy and Attention Directing Strategy have significantly different patterns of mean scores, favoring the use of these strategies for spatial learning tasks. Looking at figure 2 reveals the source of this difference. Note the higher mean scores on the (EP + IC, AD), (EP + IC) and (EP + AD) conditions compared to the EP, SP, and (SP + IC, AD), (SP + IC) and (SP + AD) conditions, on the Spatial Learning Problem. While not as strong a difference, the EP, and EP plus program embedded strategy conditions had higher scores, than the SP, and SP plus program embedded strategy conditions on the Spatial Learning Cued Recall Task.

So clearly this pattern of means indicates that the program embedded strategies of Imagery Cue Strategy and Attention Directing Strategy are beneficial for Spatial Learning Tasks. The Imagery Cue Strategy, in combination with the Attention Directing Strategy, seems to have the most beneficial effect on acquiring spatial information, and is somewhat helpful for learning lists of verbal information. It is likely, that the Imagery Cue Strategy is beneficial because of the memory effects of forming and manipulating mental images during learning. This would have its strongest impact on performance tasks requiring the reconstruction of visual or spatial information, and the analysis of spatial relationships. This, of course is exactly what the Spatial Learning Task required. The Attention Directing Strategy probably aided the learner in identifying relevant from irrelevant, or background information, and had the same effect as an advance organizer. An interesting result is that the Imagery Cue Strategy and Attention Directing Strategy was helpful to those in the EP, MCBI conditions on all learning tasks, visual and verbal, but did not seem to help those in the SP, MCBI conditions. This is a particularly significant result. Note that the pattern of means for the SP, MCBI conditions using the program embedded strategies is different, indicating lower mean scores, than the EP, MCBI conditions using the same strategies. However, the SP only group had a similar

performance on the verbal learning tasks (Simple Concept & Complex Concept) as did the EP plus program embedded strategies groups, but a poorer performance on the spatial learning tasks (Spatial Cued and Spatial Problem). It is likely that the SP conditions adopted their own learning strategies, and for college students dealing with verbal learning tasks, these were effective. It seems that the EP groups were more willing to use available program embedded strategies.

The results of this study partially supported hypotheses 1, indicating that the EP, MCBI design is superior to the SP, MCBI design for some learning tasks. Hypothesis 2 was supported by these results, indicating that the Imagery Cue Strategy did improve the learning of spatial information. Hypothesis 3 was supported indicating that the Attention Directing Strategy can improve learning, by operating like an advance organizer. Hypothesis 4 was supported indicating that the Imagery Cue Strategy and Attention Directing Strategy, in combination can improve the learning of spatial information, over either strategy alone. Finally, Hypothesis 5 was supported, finding different effects on the use of program embedded strategies. The use of program embedded learning strategies seems to be less effective for the SP-MCBI design, and more effective for the EP-MCBI design.

Conclusion

The results of this study indicate that program embedded strategies can be effective in acquiring certain types of information, with certain types of MCBI designs. If spatial information is an important part of what should be learned, an Imagery Cue Strategy can help learning. The formation and manipulation of mental images can help the learner acquire information of a spatial nature and reconstruct that information from memory, for later recall and application. Strategies that serve as advance organizers can be particularly helpful in pointing out relevant to-be-learned information. While the Attention Directing Strategy amounted to a 5-second time delay, this gave the learners enough of a cue to concentrate on the relevant visual information. Of course, it is logical that these strategies in combination would provide a more potent learning effect, since advance organizers, and an imagery strategy, would help the learner identify what to learn and significantly aid memory. The Imagery Cue Strategy and Attention Directing Strategy can help learning, and in particular the learning of visual information from MCBI. However, they seem to have their most beneficial effect with an EP-MCBI design, not an SP-MCBI design. The EP-MCBI design seems to allow the learner to better adapt to program embedded strategies, and learn more using these strategies. It is not known why this occurred, the only hypothesis

currently is that the SP-MCBI design groups, may have been trying to use their own strategies, which were inconsistent with the program embedded strategies.

From a practical point of view the results of this study clearly indicate that program embedded strategies can help learning, particularly if they are related to psychological factors. In the present study the psychological factors these strategies related to were imagery, and the advanced organization of information in the cognitive structure. In addition, the External Paced MCBI design provides for better adaptation of these program embedded strategies, than Self Paced. From a research point of view these results can lead to additional studies on other cognitive based learning strategies, alternative MCBI designs, and effects upon different learning tasks and materials further work should also be done on MCBI design types, learning strategies, and cognitive style variables.

<u>Between Subjects</u>	<u>MS</u>	<u>DF</u>	<u>F-Ratio</u>	<u>Probability</u>
Instruction Con- dition (A) (MCBI Program)	527.65	8	7.881	.0001
Error Between	66.95	171	-----	-----
<u>Within Subjects</u>				
Test Type (B)	366.00	4	63.348	.0001
(A) x (B) (Interaction)	30.41	32	5.264	.0001
Error Within	5.78	684	-----	-----

Anovr Summary, Table 1.

	SP	SP, IC+AD	SP, IC	SP, AD	EP	EP IC+AP	EP, IC	EP, AD	C	Main Effect Within	Control Group Out
List	12.0	13.0	12.60	12.15	12.10	13.55	14.35	12.60	2.7	11.67	12.79
Spatial Cued	12.20	11.30	10.85	10.60	12.45	13.40	12.85	13.25	6.15	11.45	12.11
Simple Concept	12.30	9.0	10.40	9.60	11.30	10.70	12.70	11.35	6.8	10.46	10.92
Complex Concept	11.80	9.15	10.65	10.50	12.80	11.45	11.90	10.75	7.4	10.71	11.13
Spatial Problem	8.25	8.8	7.80	6.9	8.15	12.10	10.60	9.30	.9	8.09	8.99
Main Effect Between	11.31	10.25	10.46	9.95	11.36	12.24	12.48	11.45	4.79	-----	-----

Table of Main and Simple Effect Means, Table 2.

Simple Effect Means

SP	SP+IC+AD	SP+IC	SP+AD	EP	ED+IC+AD	EP+IC	EP+AD
12 _L -12.2 _S = .20	13 _L -11.3 _S = 1.7	12.6 _L -10.85 _S = 1.75	12.15 _L -10.6 _S = 1.55	12.1 _L -12.45 _S = .35	13.55 _L -13.4 _S = .15	14.35 _L -12.85 _S = 1.5	12.6 _L -13.25 _S = .65
12 _L -12.3 _{SC} = .30	13 _L -9.0 _{SC} = (4.0)	12.6 _L -10.4 _{SC} = 2.2	12.15 _L -9.6 _{SC} = (2.55)	12.1 _L -11.3 _{SC} = .80	13.55 _L -10.7 _{SC} = (2.85)	14.35 _L -12.7 _{SC} = 1.65	12.6 _L -11.35 _{SC} = 1.25
12 _L -11.8 _{CC} = .20	13 _L -9.15 _{CC} = (3.85)	12.6 _L -10.65 _{CC} = 1.95	12.15 _L -10.5 _{CC} = 1.65	12.1 _L -12.8 _{CC} = .70	13.55 _L -11.45 _{CC} = 2.1	14.35 _L -11.9 _{CC} = 2.45	12.6 _L -10.75 _{CC} = 1.85
12 _L -8.25 _{SP} = (3.75)	13 _L -8.8 _{SP} = (4.2)	12.6 _L -7.8 _{SP} = (4.8)	12.15 _L -6.9 _{SP} = (5.25)	12.1 _L -8.15 _{SP} = (3.95)	13.55 _L -12.1 _{SP} = 1.45	14.35 _L -10.6 _{SP} = (3.75)	12.6 _L -9.3 _{SP} = (3.3)
12.2 _{SC} -12.3 _{SC} = .10	11.3 _{SC} -9.0 _{SC} = 2.3	10.85 _{SC} -10.4 _{SC} = .45	10.6 _{SC} -9.6 _{SC} = 1.0	12.45 _{SC} -11.3 _{SC} = 1.15	13.4 _{SC} -10.7 _{SC} = (2.7)	12.85 _{SC} -12.7 _{SC} = .15	13.25 _{SC} -11.35 _{SC} = 1.9
12.2 _{SC} -11.8 _{CC} = .40	11.3 _{SC} -9.15 _{CC} = 2.15	10.85 _{SC} -10.65 _{CC} = .20	10.6 _{SC} -10.5 _{CC} = .10	12.45 _{SC} -12.8 _{CC} = .35	13.4 _{SC} -11.45 _{CC} = 1.95	12.85 _{SC} -11.9 _{CC} = .95	13.25 _{SC} -10.75 _{CC} = (2.5)
12.2 _{SC} -8.25 _{SP} = (3.95)	11.3 _{SC} -8.8 _{SP} = (2.5)	10.85 _{SC} -7.8 _{SP} = (3.05)	10.6 _{SC} -6.9 _{SP} = (3.70)	12.45 _{SC} -8.15 _{SP} = (4.30)	13.4 _{SC} -12.1 _{SP} = 1.3	12.85 _{SC} -10.6 _{SP} = 2.25	13.25 _{SC} -9.3 _{SP} = (3.95)
12.3 _{SC} -11.8 _{CC} = .50	9.0 _{SC} -9.15 _{CC} = .15	10.4 _{SC} -10.65 _{CC} = .25	9.6 _{SC} -10.5 _{CC} = .90	11.3 _{SC} -12.8 _{CC} = 1.50	10.7 _{SC} -11.45 _{CC} = .75	12.7 _{SC} -11.9 _{CC} = .80	11.35 _{SC} -10.75 _{CC} = .60
12.3 _{SC} -8.25 _{SP} = (4.05)	9.0 _{SC} -8.8 _{SP} = .20	10.4 _{SC} -7.8 _{SP} = (2.6)	9.6 _{SC} -6.9 _{SP} = (2.7)	11.3 _{SC} -8.15 _{SP} = (3.15)	10.7 _{SC} -12.1 _{SP} = 1.4	12.7 _{SC} -10.6 _{SP} = 2.1	11.35 _{SC} -9.3 _{SP} = 2.05
11.8 _{CC} -8.25 _{SP} = (3.55)	9.15 _{CC} -8.8 _{SP} = .35	10.65 _{CC} -7.8 _{SP} = (2.85)	10.5 _{CC} -6.9 _{SP} = (3.6)	12.3 _{CC} -8.15 _{SP} = (4.65)	11.45 _{CC} -12.1 _{SP} = .65	11.9 _{CC} -10.6 _{SP} = 1.3	10.75 _{CC} -9.3 _{SP} = 1.45

Simple Effects; Table 3.

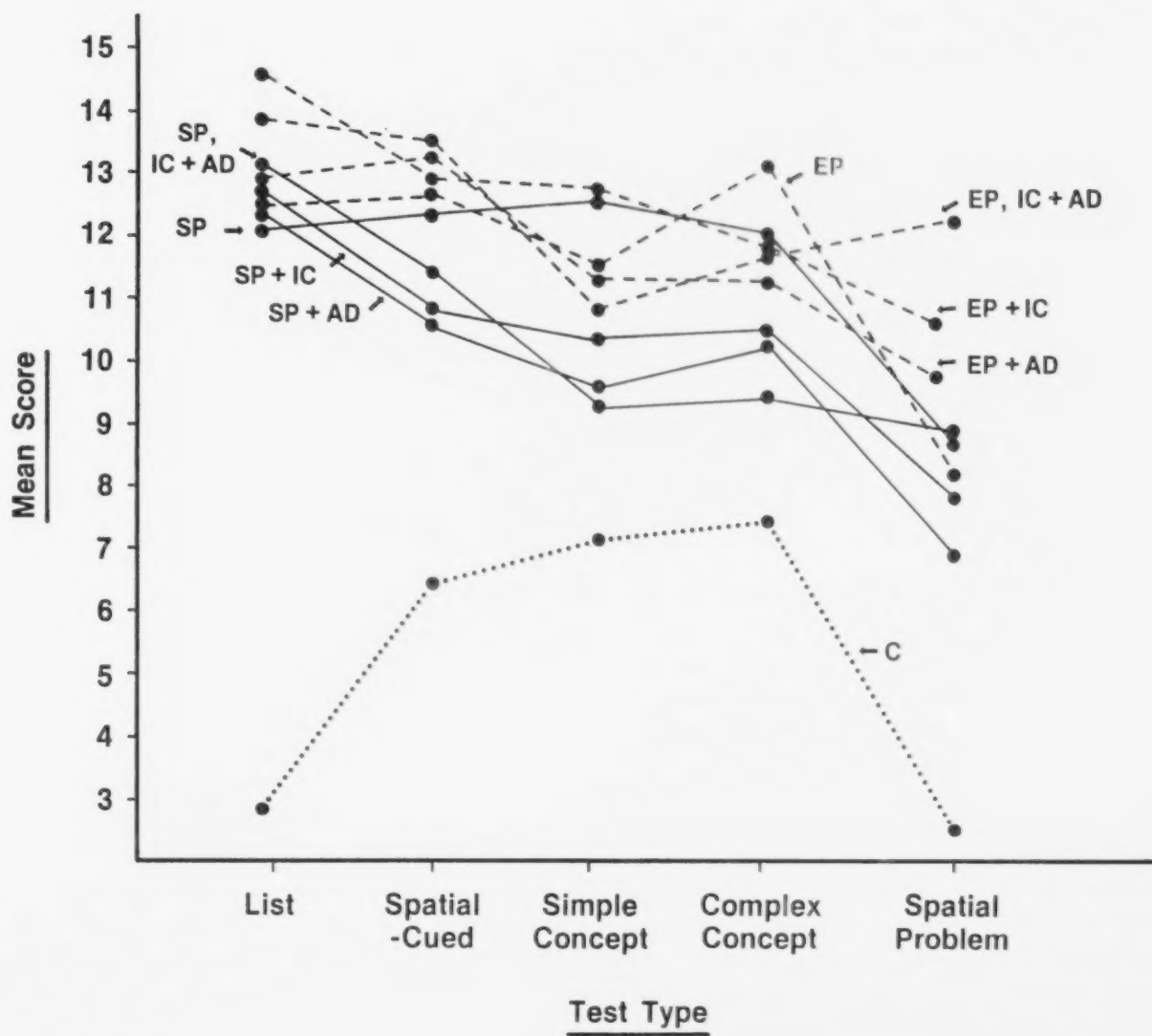
Alpha = (.01)
Significant Differences = ()

List=L, Spatial Cued=S, Simple Concept=SC
Complex Concept=CC, Spatial Problem=SP

SP=Self Paced; EP=Externally Paced; IC=Image Cue Strategy; AD=Attention Directing Strategy

	SP	SP, IC+AD	SP, IC	SP, AD	EP	EP, IC+AD	EP, IC	EP, AD	Control
List Learning	Ref. Imp.	$\frac{R}{I}$	$\frac{R}{I}$	$\frac{R}{I}$	$\frac{R}{I}$	$\frac{R}{I}$	$\frac{R}{I}$	$\frac{R}{I}$	$\frac{R}{I}$
Spatial Learning									
Cued Recall									
Simple Concept Learning									
Complex Concept Learning									
Spatial Learning Problem									

Figure 1 - Overall Experimental Design



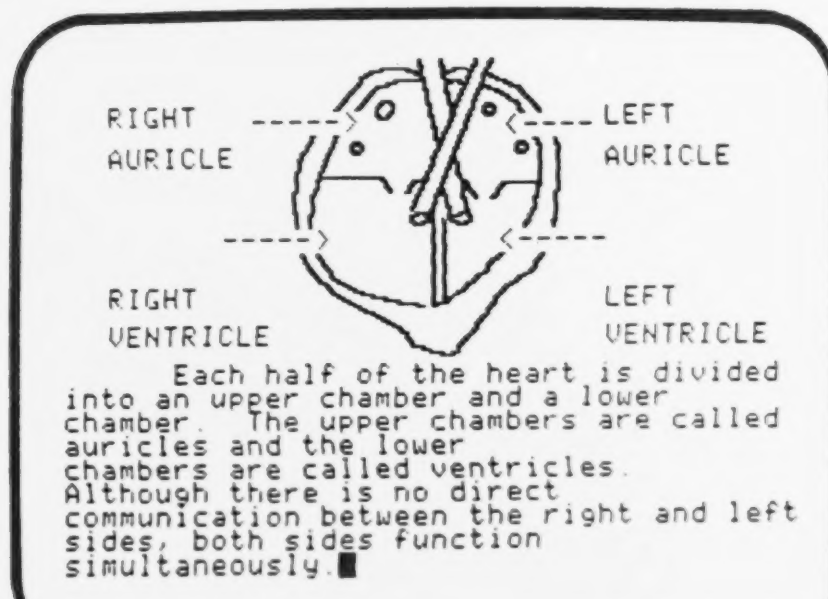


Figure 3 - Sample heart visual types,
and Sample Complete
Instructional Display.

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